Virtual National Laboratory for Heavy Ion Fusion

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HIF News

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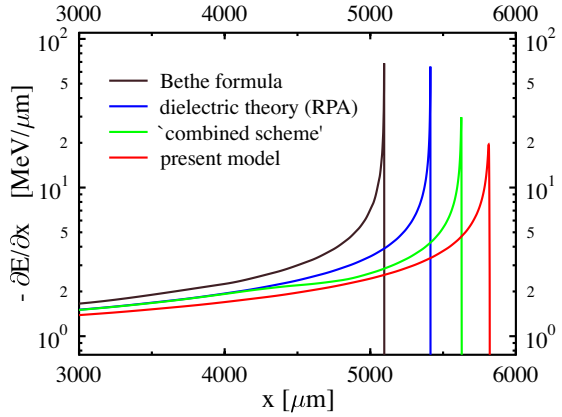
Ion stopping in HIF converters

The exact energy deposition profile of heavy ions in ionized matter is needed to design efficient HIF capsules. Due to high beam ion charge states and target densities, strong beam-plasma correlations occur in HIF converters during the heating process. In the present energy loss model, these correlations were described through an exact T-matrix treatment considering statically screened interactions. Collective effects are included with a velocity dependent screening length. The numerical results, that agree well with molecular dynamics and particle in cell simulations, can be summarized in a fit shown in red in the figure, the details of the fit can be viewed online at http://hifnews.lbl.gov

In the figure, the present model is compared with two weak coupling theories and an approach that considers correlations and dynamic screening only approximately (combined model). Evidently, a correct description of strong beam-plasma correlations gives a smaller energy transfer and, therefore, larger ranges. *– Dirk O. Gericke*

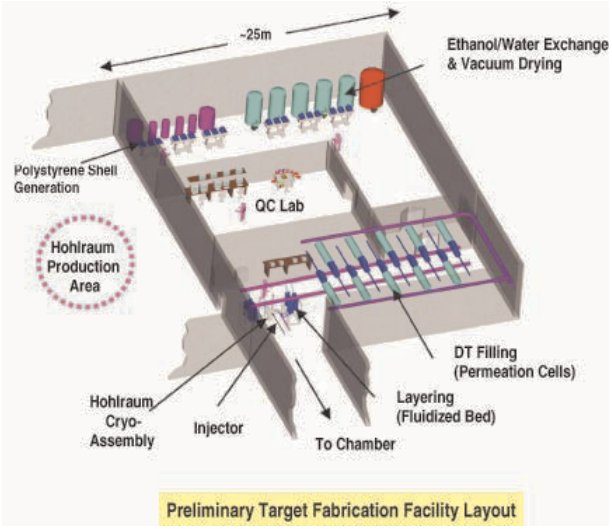


Energy loss of an $^{209}Bi^{50+}$ ion in an electron gas with $T = 5\times10^{7}$K and $n = 10^{23}$ cm^{-3}. The initial ion energy is $E(x=0) = 50$MeV/u.

Credible Pathway for Heavy Ion Driven Target Fabrication and Injection

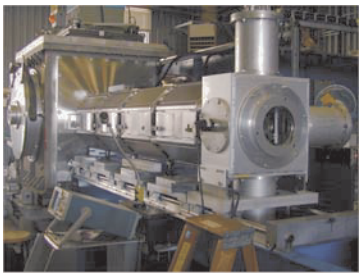
It is necessary to supply about 500,000 targets per day for a commercial-scale 1000 MW(e) heavy-ion-driven inertial-fusion reactor. The targets (distributed radiator design of Debbie Callahan) include polystyrene shells, which are produced with a microencapsulation process, vacuum dried, filled with DT, layered at cryogenic temperatures, assembled into a precision hohlraum containing a number of unique reduced-density materials and recycled precious metals, and transferred for injection into the chamber. The feasibility of producing targets at the required rates and for low cost (about $0.30 per target) is a major feasibility issue for heavy ion fusion. A development program is underway to establish a "credible pathway" for heavy ion driven target fabrication and injection.

For the first time, potential methodologies have been identified for every step of this complex manufacturing sequence - as reported at the HIF2002 conference in Moscow in May. Proof of principle experiments for these methodologies are underway or planned. In addition, a Target Fabrication Facility layout for many of the steps (i.e., shell manufacture, filling, layering, and injecting) has been prepared. Chemical engineering scale-up principles and established estimating methods have been utilized to give a cost estimate of $0.11 for each filled and layered shell in commercial production. This is an encouraging result, as it leaves significant margin for the manufacture of the hohlraum components and assembly of the hohlraum and the shells. *- Dan Goodin and Bill Rickman.*

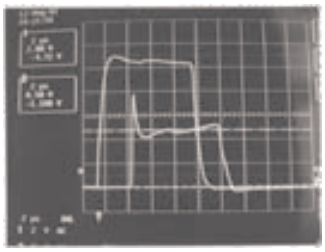


First Beam through magnetic transport in NTX

Heavy-ion fusion power plant costs would be reduced with lower energy accelerators, however the multi-megajoule ion beams cannot then be focused to the required few mm spot sizes unless space-charge blow-up is reduced by neutralizing the beams.



NTX has been constructed to study the physics of beam neutralization after the final focus magnets, using high perveance beams that can be focused to small spot sizes only with neutralized transport.



On 8/8/02, the Neutralized transport experiment produced the first beam at the exit of the magnetic lattice. The lattice consists of 4 pulsed quadrupoles which have been tested for over 1000 shots at 8kG (20% above operating current). The potassium ion beam at the source was demonstrated to have an emittance four times lower than the requirements dictated by neutralization physics. This was accomplished by a novel beam aperturing technique. Detailed characterization of beam transport through the magnetic lattice is now in progress. This work prepares the beam for injection into the plasma neutralization section to be installed downstream of the magnetic lattice.

-Simon Yu.

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